CLAIMS

What is claimed is:

1. A saturable absorber Q-switch, comprising a monocrystalline lattice having a formula $Mg_{1-x}Co_xAl_yO_z$ where x is greater than 0 and less than about 1, y is greater than 2 and less than about 8, and z is between about 4 and about 13, said lattice having tetrahedral and octahedral positions, and wherein most of the magnesium and cobalt occupy tetrahedral positions.

2. The saturable absorber Q-switch of Claim 1, wherein essentially all of the cobalt and magnesium occupy tetrahedral positions.

3. The saturable absorber Q-switch of Claim 2, wherein the unit cell dimension is between about 7.970Å and about 8.083 Å.

4. The saturable absorber Q-switch of Claim 3, wherein z is about 4.

5. The saturable absorber Q-switch of Claim 3, wherein y is about 4 and z is about 7.

6. The saturable absorber Q-switch of Claim 3, wherein y is about 6 and z is about 10.

7. The saturable absorber Q-switch of Claim 3, wherein cobalt is present in the monocrystalline lattice in an amount between about 0.02 atomic weight percent and about 0.043 atomic weight percent.

8. The saturable absorber Q-switch of Claim 1, having an absorption band of between about 1537 and about 1544nm.

9. The saturable absorber Q-switch of Claim 8, having an absorption band of about 1537nm.

10. The saturable absorber Q-switch of Claim 8, having an absorption band of about 1539nm.

11. The saturable absorber Q-switch of Claim 8, having an absorption band of about 1544nm.

12. The saturable absorber Q-switch of Claim 1, having an absorption band of about 1337nm.

13. The saturable absorber Q-switch of Claim 1, having an absorption band of about 1360nm.

14. The saturable absorber Q-switch of Claim 1, having an absorption band of about 1365nm.

15. The saturable absorber Q-switch of Claim 1, having a decay time, τ_{31}, greater than about $30x10^{-6}$ seconds.

16. A laser system, comprising:

a) a laser resonator cavity defined by a flat mirror and an outcoupler mirror, said flat mirror and said outcoupler mirror oriented to form an optical resonant axis;

b) a lasing element within the laser resonator cavity;

c) optical pumping means proximate to said lasing element; and

d) a saturable absorber Q-switch lying along the resonant axis, said Q-switch including a monocrystalline lattice having a formula $Mg_{1-x}Co_xAl_yO_z$, where x is greater than 0 and less than about 1, y is greater than 2 and less than about 8, and z is between about 4 and about 13, said lattice having tetrahedral and octahedral positions, and wherein most of the magnesium and cobalt occupy tetrahedral positions.

17. The laser system of Claim 16, wherein essentially all of the magnesium and cobalt occupy tetrahedral positions.

18. The laser system of Claim 17, wherein the saturable absorber Q-switch has an absorption band within about 4nm of the lasing transition of the lasing element.

19. The laser system of Claim 18, wherein the saturable absorber Q-switch has an absorption band within about 2nm of the lasing transition of the lasing element.

20. The laser system of Claim 17, wherein the lasing element is an Er:Yb:glass (Er^{3+}:glass?) lasing element.

21. The laser system of Claim 20, wherein the saturable absorber Q-switch has an absorption band of about 1537nm.

22. The laser system of Claim 20, wherein the saturable absorber Q-switch has an absorption band of about 1544nm.

23. The laser system of Claim 17, wherein the lasing element is a Nd^{3+}:$YAlO_3$ lasing element.

24. The laser system of Claim 23, wherein the saturable absorber Q-switch has an absorption band of about 1360nm.

25. The laser system of Claim 23, wherein the saturable absorber Q-switch has an absorption band of about 1365nm.

26. The laser system of Claim 23, wherein the saturable absorber Q-switch has an absorption band of about 1337nm.

27. The laser system of Claim 17, wherein the unit cell dimension of the saturable absorber Q-switch is between about 7.970Å and about 8.083Å.

28. The laser system of Claim 27, wherein y is about 2 and z is about 4.

29. The laser system of Claim 23, wherein y is about 4 and z is about 7.

30. The laser system of Claim 27, wherein y is about 6 and z is about 10.

31. The laser system of Claim 27, wherein cobalt is present in the monocrystalline lattice in an amount between about 0.020 atomic weight percent and about 0.043 atomic weight percent.

32. The laser system of Claim 17, wherein saturable absorber Q-switch has a decay time, τ_{31}, greater than about $30x10^{-6}$ seconds.

33. A method of forming a monocrystalline lattice of a saturable absorber Q-switch, comprising the steps of:

a) forming a melt that includes magnesium, cobalt, aluminum and oxygen, wherein the molar ratio of magnesium:cobalt:aluminum is (1-x):x:y,

where x is greater than 0 and less than about 1, and y is greater than 2 and less than about 8;

b) immersing a spinel seed crystal in the melt; and

c) rotating the seed crystal at a rate in a range of between about 2 and about 12 revolutions per minute, while withdrawing the seed crystal from the melt at a rate in a range of between about 0.04"/hr and about 0.1"/hr to thereby form said monocrystalline lattice.

34. The method of Claim 33, wherein the melt is formed by a method, comprising the steps of:

a) combining MgO, Co_3O_4 and Al_2O_3 powders; and

b) heating the combined powders to a temperature sufficient to form the melt.

35. The method of Claim 34, wherein the spinel seed crystal is cylindrical.

36. The method of Claim 35, wherein the spinel seed is aligned along a <111> axis in the melt.

37. The method of Claim 36, wherein growth of the crystal continues for a period of time in a range of between about 200 and about 800 hours to form a crystal having a weight in a range of between about 200 and about 2500 gms.

38. The method of Claim 37, wherein the crystal has a diameter in a range of between about 1.25" and about 3".

39. The method of Claim 38, wherein the melt is heated to a temperature greater than about 2150°C.

40. The method of Claim 39, wherein the crystal is cooled to a temperature in a range of between about 20°C and 30°C over a period of time in a range of between about 48 and about 120 hours.

41. The method of Claim 33, wherein y is about 2.

42. The method of Claim 33, wherein y is about 4.

43. The method of Claim 33, wherein y is about 6.

44. The method of Claim 33, wherein y is about 8.

45. The method of Claim 33, wherein x is in a range of between about 0.0001 and about 0.03.

46. The method of Claim 45, wherein cobalt is present in the melt in a range of between about 0.020 atomic weight percent and about 0.043 atomic weight percent.

47. In a saturable absorber Q-switch that includes a monocrystalline lattice of cobalt-doped spinel:

The improvement comprising a molar ratio of aluminum to the combined molar amount of cobalt and magnesium that is greater than 2, and wherein essentially all of the cobalt and magnesium occupy tetrahedral positions of the monocrystalline lattice.